CLAIMS

We claim:

1. A system to actuate downhole tools by light, comprising:

a downhole tool adapted to be deployed in a wellbore;

an optical transmitter optically connected to the downhole tool through an optical fiber;

the optical transmitter adapted to transmit an optical signal through the optical fiber; and

wherein the downhole tool is activated in response to reception of the optical signal.

2. The system of claim 1, wherein the optical transmitter is located at the surface of the wellbore.

3. The system of claim 1, wherein the optical signal comprises light at a specific frequency.

4. The system of claim 3, wherein the optical signal comprises light at a plurality of frequencies.

5. The system of claim 3, wherein the optical signal also comprises light at a specific intensity, wavelength, or amount.

6. The system of claim 1, wherein the optical signal comprises light at a specific intensity.

7. The system of claim 6, wherein the optical signal comprises light at a plurality of intensities.

8. The system of claim 6, wherein the optical signal also comprises light at a specific frequency, wavelength, or amount.

9. The system of claim 1, wherein the optical signal comprises light at a specific wavelength.

10. The system of claim 9, wherein the optical signal comprises light at a plurality of wavelengths.

11. The system of claim 9, wherein the optical signal also comprises light at a specific frequency, intensity, or amount.

12. The system of claim 1, wherein the optical signal comprises light at a specific amount.

13. The system of claim 12, wherein the optical signal also comprises light at a specific intensity, frequency, or wavelength.

14. The system of claim 1, wherein the optical signal comprises at least one pulse.

15. The system of claim 14, wherein the optical signal comprises a specific number of optical pulses.

16. The system of claim 14, wherein the optical signal comprises at least one pulse with a specific time duration.

17. The system of claim 14, wherein the optical signal comprises at least one pulse of light at a specific intensity, frequency, wavelength, or amount.

18. The system of claim 1, wherein the downhole tool is selected from the group consisting of a packer, a perforating gun, a valve, a sampler, a sensor, a pump, a screen, a chemical cutter, a plug, a detonator, or a nipple.

19. The system of claim 1, wherein the downhole tool is incorporated in a logging system.

20. The system of claim 1, wherein the downhole tool is incorporated in a permanent completion.

21. The system of claim 1, wherein the downhole tool is incorporated in a coiled tubing system.

22. The system of claim 1, wherein the optical fiber is deployed within a conduit.

23. The system of claim 1, wherein the optical fiber is incorporated into a wireline.

24. The system of claim 1, wherein the optical fiber is incorporated into a slickline.

25. The system of claim 1, further comprising a receptor for receiving the optical signal.

26. The system of claim 1, wherein the receptor receives the optical signal, verifies the optical signal is a valid triggering signal, and subsequently enables the activation of the downhole tool.

27. The system of claim 26, wherein the receptor is adapted to compare the optical signal to the valid triggering signal.

28. The system of claim 27, wherein:

the receptor comprises a microprocessor, storage, and a controller;

the valid triggering signal is stored in the storage;

the microprocessor compares the optical signal to the valid triggering signal; and

the microprocessor activates the controller when the optical signal matches the stored valid triggering signal.

29. The system of claim 26, wherein the receptor includes components that function only when exposed to the correct triggering signal.

30. The system of claim 1, wherein a plurality of downhole tools are functionally connected to the optical fiber so that each of the downhole tools may be activated in response to the reception of the optical signal.

31. The system of claim 30, wherein a different optical signal activates different downhole tools.

32. The system of claim 30, further comprising at least one optical filter functionally connected to the optical fiber that allows only light at a specific wavelength to pass therethrough to activate a downhole tool.

33. The system of claim 32, wherein a filter is associated with each downhole tool.

34. The system of claim 33, wherein each filter allows light of different wavelengths therethrough.

35. The system of claim 30, further comprising at least one coupler functionally connected to the optical fiber that diverts only light at a specific wavelength towards a downhole tool to activate such downhole tool.

36. The system of claim 35, wherein an optical coupler is associated with each downhole tool.

37. The system of claim 36, wherein each coupler diverts light of different wavelengths.

38. The system of claim 1, wherein the optical signal is converted into electrical energy.

39. The system of claim 38, wherein:

the optical signal is received by at least one photodiode;

the at least one photodiode converts the optical signal into electrical energy; and

the electrical energy is transmitted to an initiator circuit to activate the downhole tool.

40. The system of claim 1, wherein the optical signal is converted into chemical energy.

41. The system of claim 40, wherein:

the optical signal is transmitted into an optically reactive chemical chamber;

the chamber contains an optically reactive substance that chemically reacts when subjected to light; and

the chemical energy is transferred to activate the downhole tool.

42. The system of claim 41, wherein the chamber includes an environment conducive to chemical reaction of the substance to light.

43. The system of claim 41, wherein the reaction is one of heating, exploding, or deteriorating.

44. The system of claim 1, wherein the optical signal is converted into mechanical energy.

45. The system of claim 44, wherein:

the optical signal is converted into an electrical signal and is then transmitted into a piezoelectric stack that expands when exposed to electrical energy; and

the expansion of the stack is used to activate the downhole tool.

46. The system of claim 1, further comprising a casing collar locator used to determine the depth of the downhole tool.

47. A method to actuate downhole tools by light, comprising:

deploying a downhole tool in a wellbore;

optically connecting the downhole tool to an optical transmitter through an optical fiber;

transmitting an optical signal from the optical transmitter through the optical fiber;

activating the downhole tool in response to reception of the optical signal.

48. The method of claim 47, wherein the transmitting step comprises transmitting an optical signal including light at a specific frequency.

49. The method of claim 48, wherein the transmitting step comprises transmitting an optical signal including light at a plurality of frequencies.

50. The method of claim 48, wherein the transmitting step comprises transmitting an optical signal including light at a specific intensity, wavelength, or amount.

51. The method of claim 47, wherein the transmitting step comprises transmitting an optical

signal including light at a specific intensity.

52. The method of claim 51, wherein the transmitting step comprises transmitting an optical signal including light at a plurality of intensities.

53. The method of claim 51, wherein the transmitting step comprises transmitting an optical signal including light at a specific frequency, wavelength, or amount.

54. The method of claim 47, wherein the transmitting step comprises transmitting an optical signal including light at a specific wavelength.

55. The method of claim 54, wherein the transmitting step comprises transmitting an optical signal including light at a plurality of wavelengths.

56. The method of claim 54, wherein the transmitting step comprises transmitting an optical signal including light at a specific frequency, intensity, or amount.

57. The method of claim 47, wherein the transmitting step comprises transmitting an optical signal including light at a specific amount.

58. The method of claim 57, wherein the transmitting step comprises transmitting an optical signal including light at a specific intensity, frequency, or wavelength.

59. The method of claim 47, wherein the transmitting step comprises transmitting an optical signal including at least one pulse.

60. The method of claim 59, wherein the transmitting step comprises transmitting an optical signal including a specific number of optical pulses.

61. The method of claim 59, wherein the transmitting step comprises transmitting an optical signal including at least one pulse with a specific time duration.

62. The method of claim 59, wherein the transmitting step comprises transmitting an optical signal including at least one pulse of light at a specific intensity, frequency, wavelength, or amount.

63. The method of claim 47, wherein the downhole tool is selected from the group consisting of a packer, a perforating gun, a valve, a sampler, a sensor, a pump, a screen, a chemical cutter, a plug, a detonator, or a nipple.

64. The method of claim 47, wherein the deploying step comprises deploying the downhole tool as part of a logging system.

65. The method of claim 47, wherein the deploying step comprises deploying the downhole tool as part of a permanent completion.

66. The method of claim 47, wherein the deploying step comprises deploying the downhole tool as part of a coiled tubing system.

67. The method of claim 47, further comprising deploying the optical fiber within a conduit.

68. The method of claim 47, further comprising incorporating the optical fiber into a wireline.

69. The method of claim 47, further comprising incorporating the optical fiber into a slickline.

70. The method of claim 47, further comprising comparing the optical signal to a valid triggering signal.

71. The method of claim 47, further comprising functionally connecting a plurality of downhole tools to the optical fiber so that each of the downhole tools may be activated in response to the reception of the optical signal.

72. The method of claim 71, further comprising utilizing a different optical signal to activate different downhole tools.

73. The method of claim 71, further comprising functionally connecting at least one optical filter to the optical fiber, the optical filter allowing only light at a specific wavelength to pass

therethrough to activate a downhole tool.

74. The method of claim 73, further comprising functionally connecting a filter for each downhole tool.

75. The method of claim 74, further comprising utilizing filters that allow light of different wavelengths therethrough.

76. The method of claim 71, further comprising functionally connecting at least one coupler to the optical fiber, the coupler diverting only light at a specific wavelength towards a downhole tool to activate such downhole tool.

77. The method of claim 76, further comprising functionally connecting a coupler for each downhole tool.

78. The method of claim 77, further comprising utilizing couplers that divert light of different wavelengths.

79. The method of claim 47, further comprising converting the optical signal into electrical energy.

80. The method of claim 79, further comprising:

receiving the optical signal at an at least one photodiode, the at least one photodiode

converting the optical signal into electrical energy; and

transmitting the electrical energy to an initiator circuit to activate the downhole tool.

81. The method of claim 47, further comprising converting the optical signal into chemical energy.

82. The method of claim 81, further comprising:

transmitting the optical signal into an optically reactive chemical chamber;

providing an optically reactive substance in the chamber that chemically reacts when subjected to light; and

transferring the chemical energy to activate the downhole tool.

83. The method of claim 82, further comprising providing an environment conducive to initiating the chemical reaction of the substance when exposed to light.

84. The method of claim 82, wherein the chemical reaction is one of heating, exploding, or deteriorating.

85. The method of claim 1, further comprising converting the optical signal into mechanical energy.

86. The method of claim 85, further comprising:

converting the optical signal into an electrical signal;

transmitting the electrical signal into a piezoelectric stack that expands when exposed to electrical energy; and

utilizing the expansion of the stack to activate the downhole tool.

87. The method of claim 47, further comprising determining the depth of the downhole tool by using a casing collar locator.

88. A downhole gun assembly used in a subterranean wellbore, comprising:

at least one shaped charge;

an optical fiber functionally connected to an optical transmitter; and

wherein the transmission of an optical signal by the optical transmitter through the optical fiber results in the activation of the at least one shaped charge.

89. The assembly of claim 88, further comprising an optical filter functionally attached to the optical fiber, the optical filter allowing only light at a specific frequency to pass therethrough.

90. The assembly of claim 88, further comprising:

a converter adapted to convert the optical signal into electrical power;

a prima cord functionally attached to the at least one shaped charge;

a firing circuit that receives the electrical power and ignites the prima cord in response thereto; and

wherein the at least one shaped charge is activated after the ignition of the prima cord.

91. The assembly of claim 90, further comprising an optical filter functionally attached to the optical fiber and preceding the converter, the optical filter allowing only light at a specific frequency to pass therethrough.

92. The assembly of claim 88, further comprising:

a prima cord functionally attached to the at least one shaped charge;

a material in optical communication with the optical fiber;

the material adapted to ignite when exposed to light at a certain intensity level; and

so that when the material ignites in response to exposure to light at the certain intensity level, the prima cord is ignited resulting in the activation of the at least one shaped charge.

93. The assembly of claim 92, wherein the material is included in a chamber that contains a substance that is conducive to the ignition of the material.

94. The assembly of claim 93, wherein the optical fiber and the prima cord extend into the chamber.

95. The assembly of claim 93, wherein the material surrounds the optical fiber.

96. The assembly of claim 95, wherein the material is coated onto the optical fiber.

97. The assembly of claim 92, further comprising an explosive that ignites once the material has ignited and that transfers the energy to ignite the prima cord.

98. The assembly of claim 92, wherein the material comprises one selected from the group consisting of silcon, iron oxide, coal, charcoal, or thermite.

99. The assembly of claim 93, wherein the substance comprises one selected from the group consisting of air mixed with diethyl ether, ether, carbon disulphide, or n-pentane.

100. The assembly of claim 92, wherein the material is porous.

101. A method to activate a downhole gun assembly used in a subterranean wellbore, comprising:

deploying a gun assembly in a wellbore;

transmitting an optical signal from an optical transmitter to the gun assembly via an optical fiber; and

activating at least one shaped charge of the gun assembly in response to reception of the optical signal.

102. The method of claim 101, further comprising filtering light being transmitted through the optical fiber that does not correspond to a specific frequency.

103. The method of claim 101, further comprising:

converting the optical signal into electrical power;

transmitting the electrical power to a firing circuit; and

igniting a prima cord that is functionally attached to the at least one shaped charge, wherein the at least one shaped charge is activated after the ignition of the prima cord.

104. The method of claim 103, further comprising filtering light being transmitted through the optical fiber that does not correspond to a specific frequency, the filtering step occurring prior to the converting step.

105. The method of claim 101, further comprising:

igniting a material that is in optical communication with the optical fiber, the material adapted to ignite when exposed to light at a certain intensity level;

igniting a prima cord that is functionally attached to the at least one shaped charge in response to the igniting a material step; and

wherein the at least one shaped charge is activated after the ignition of the prima cord.

106. The method of claim 105, further comprising surrounding the material with a substance that is conducive to the ignition of the material.

107. The method of claim 105, further comprising igniting an explosive in response to the igniting a prima cord step, which ignition results in the ignition of the prima cord.

108. The method of claim 105, wherein the material comprises one selected from the group consisting of silcon, iron oxide, coal, charcoal, or thermite.

109. The method of claim 106, wherein the substance comprises one selected from the group consisting of air mixed with diethyl ether, ether, carbon disulphide, or n-pentane.